Feature Article

Entering the Public Health Genomics Era: Why Must Health Educators Develop Genomic Competencies?

Lei-Shih Chen and Patricia Goodson

ABSTRACT

Although the completion of the Human Genome Project will offer new insight into diseases and help develop efficient, personalized treatment or prevention programs, it will also raise new and non-trivial public health issues. Many of these issues fall under the professional purview of public health workers. As members of the public health workforce, health educators are being called upon to deal with genomic-related public health topics. Thus, we propose five arguments supporting the need for health educators to develop their genomic competencies and integrate public health genomics (PHG) into health promotion. These arguments highlight various dimensions of health educators' professional goals and range from professional responsibilities and competencies to the availability of funding for genomic-related research or interventions and opportunities for future employment. Alongside these arguments, we present key PHG terms to facilitate understanding and to establish a common set of meanings for readers. Moreover, we discuss the current efforts being made by the field of health education to integrate genomics into research and practice, as well as implications and next steps required to optimize this integration.

INTRODUCTION

In 2003, the National Institutes of Health (NIH) announced the completion of the Human Genome Project (HGP). The project represents a milestone in human history, as advanced genomic technologies/information can offer insight into specific diseases and may help develop highly efficient, personalized treatment and prevention programs.[1] According to Dr. Julie Gerberding, director of the Centers for Disease Control and Prevention (CDC), "There are exciting things going on right now in public health. Certainly, genomics is going to have a profound impact on the public health practice of the future."[2]

Yet in the wake of its completion, the HGP also raised new and non-trivial public health issues. These include, but are not restricted to, the general public's level of genetic literacy, the nature and challenges of informed consent for genetic testing, the intricate decision-making process associated with genetic testing, public fears about genetic discrimination, lack of access to genetic services, challenges regarding maintenance of healthy lifestyles following genomic profiling, the potential increase in health disparities, and insufficient knowledge or awareness of genomic information and technologies among health care providers and public health workers.[3, 4]

Many of these concerns fall under the professional purview of public health workers. Even before the completion of the HGP, scholars such as Muin Khoury (director, National Office of Public Health Genomics, CDC) recommended that public health professionals (1) understand genomic factors in population health, (2) examine the clinical validity and value of genomic tests, and (3) assess individuals' family history in order to recommend genetic evaluations, intensive screening, and/or lifestyle changes.[5] Once the HGP ended, Khoury and others called for a renewed commitment of the public health workforce to the incorporation of genomics

Lei-Shih Chen, is assistant professor in the Department of Public Health at the University of North Florida, 4567 St. Johns Bluff Road, Jacksonville, FL 32224; E-mail: lace@hlkn.tamu.edu. Patricia Goodson, is an associate professor in the Department of Health and Kinesiology at Texas A&M University, 4243 TAMU, College Station, TX 77843-4243; E-mail: pgoodson@hlkn.tamu.edu.

into public health. Khoury and Mensah,[6] for instance, postulated three immediate priorities for public health action regarding genomics: (1) investigating the relationship between genetic variants and diseases through administration of population-based surveys; (2) establishing an evidence base for various genomic technology applications, and (3) developing the capacity of the public health workforce and systems.

As members of the public health workforce, health educators also have been called upon to deal with genomic-related public health topics. In 1993, Sorenson and Cheuvront[7] authored the first paper advocating for "health behavior and health education studies to contribute to effective programs and policies"(p591) due to the increasing demands for genetic services since the beginning of the HGP. These studies would examine the utilization and effectiveness of genetic services, as well as assess the consequences of genetic testing. More recently, in what may be characterized as a unique editorial decision among health education journals, *Health Education and Behavior* devoted its entire October 2005 issue to discussing the role of, and research/practice opportunities for, health educators regarding genomics.

Despite the expectation that the public health workforce in general, and health educators in particular, have a significant role to play in the intersection of genomics and public health, the majority of them have never received formal training in genomics.[8] In 2003, the Association of Schools of Public Health (ASPH) surveyed representatives of 33 accredited U.S. public health schools. ASPH found that approximately half of these schools did not offer genomics in their curriculum, and only 15% included the topic "genomics" in their core courses.[9] Unfortunately, similar data do not exist for programs of health education/health promotion housed outside of schools of public health. However, qualitative data we collected recently (unpublished) indicated that most health educators interviewed have not formally been exposed to genomics-related topics during their training in health promotion.

Even as a large gap lies between the expectations for health educators in this post-genomic era and the training they receive, we believe it is important to develop the case, or establish the need for, their greater involvement in the upcoming genomics dimension of public health and health education. Accordingly, this article puts forth five arguments designed to persuade health educators to explore genomics, to incorporate genomic information and technologies (such as family histories) into their health promotion research and practice, and, thus, develop their genomic competencies. These arguments may also prove useful for raising health educators' awareness of public health genomics (PHG), for diminishing perceptions of incompatibility between PHG and health educators' personal beliefs and values, and for increasing health educators' motivation for engagement in genomic-related health promotion research and practice.

DEFINING KEY TERMS

Issues of terminology are inherent in all sciences and fields of practice, and PHG does not differ in this regard: knowledge of, or at least familiarity with, basic terminology is an important first step in understanding PHG's scope and target. Some scholars even propose that terminology shapes the field of genomics (as, for instance, in the choice of particular words, images, and metaphors used to communicate genetic information to the lay public; for an in-depth discussion of genomics as a form of public health discourse, see Petersen and Bunton[10]). Regardless of which philosophical perspective concerning the role of language in science one espouses, mastery of basic terminology is essential for a healthy and constructive dialogue. Nevertheless, it is important to bear in mind that, given the novelty of the field, many terms are still vaguely or ambiguously defined, exhibiting small (but important) variations in meaning. For the purpose of this article, and given the demographic characteristics of its readership, we will present those definitions most widely used within the U.S. and North American contexts. Whenever appropriate, we will note alternative definitions or potential ambiguities. This basic terminology and its most commonly used/cited definitions and delimitations are presented in Table 1 as pairs (e.g., Genetics versus Genomics) for easier comparisons between newer and more familiar terms.

WHY MUST HEALTH EDUCATORS DEVELOP GENOMIC COMPETENCIES?

For a summary listing of the arguments presented below, see Table 2.

Argument 1: Because leading professional organizations have advocated the incorporation of genomics into health promotion practice.

Over the past decade, several professional groups have supported the notion that health educators should develop their genomic competencies. The CDC, for instance, has gone as far as claiming that *every* public health professional should develop genomic competencies.[11] Such competencies specifically require health educators to

1. "Translate health related information about social and cultural environments (including community needs and interests and societal value systems) for use in population-based scientifically sound genomic health education programs;

2. Determine the factors such as learning styles, literacy, learning environment, and barriers that influence learning about genomics;

3. Differentiate between genomic education and genetic counseling;

4. Facilitate genomic education for agency staff, administrators, volunteers, community groups, and other interested personnel;

5. Utilize social marketing to develop a plan for incorporating genomics into health education services by working with community organizations, genomic experts, and other resource people for support and assistance in program planning;

6. Provide a critical analysis of current and future community genomic education needs; and

7. Advocate [for] genomic education

Table 1. The Definitions and Delimitations of Key Terms Frequently Used in Public Health Genomics in the United States

Key Terms	Definitions and Delimitations
Genomic Competencies	The term genomic competencies refers to a set of knowledge and professional skills related specifically to public health genomics. Genomic competencies were developed by a group of interdisciplinary experts in public health to ensure public health professionals could embrace up-to-date genomic knowledge and skills to promote human health and prevent diseases. Genomic competencies for public health workers—according to the CDC—include (1) "demonstrating basic knowledge of the role that genomics plays in the development of disease, (2) identifying the limits of one's genomic expertise, and (3) making appropriate referrals to those with more genomic expertise. In addition, there are genomic competencies required for public health professionals, public health leaders/administrators, public health clinicians, epidemiologists, health educators, laboratory technicians, and environmental health workers."[11]
Genetics vs. Genomics	Although genetics and genomics are often used interchangeably, the definitions of these terms differ in important ways. Genetics, originally associated with the study of Mendelian inheritance, is the research of single genes and their structure, functions, and effects. The field of genetics encompasses basic biochemical research regarding specific genes and their potential association with animal or human morbidity. The field can be subdivided into 3 major domains: classical genetics, molecular genetics, and evolutionary genetics.[27] More often than not, genetics focuses on a single, isolated gene. Many of the most popularly known diseases (albeit more rare and severe)—including cystic fibrosis, Tay-Sachs Disease, Huntington's disease, and hemophilia—are single-gene diseases.[8] Derived from the sequencing of the human genome, Genomics is an expansion of genetics, comprising the study of the entire human genome (though genomics may also apply to plant and animal sciences; for example, community genomics refers to "the analysis of species populations and their interactions, recognizing that both species composition and interactions change over time, and in response to environmental stimuli."[28]). Genomics encompasses—as does genetics—the research of a single gene's structure and function, but it moves beyond to exploring interactions among multiple genes and their functions, as well as to investigating interactions between genes and their environment(s). Thus, genomics is broader in scope than genetics. Most diseases result from interactions between genes, environment, behavior, and access to health care. Such diseases include cardiovascular illnesses, common late-onset Alzheimer's disease, obesity, non-insulin-dependent diabetes mellitus, cancers, and others. New genomic technologies have made it possible to explore genetic factors (i.e., single gene responses and gene-to-gene interactions) as well as broader interaction factors (i.e., gene-to-environment interaction) leading to disease.[8]
Old Genetics vs. New Genetics	The meaning of the term New Genetics varies based on different time periods and its uses. For example, in 1979 the term New Genetics was introduced to raise awareness of new techniques with the potential to identify genes' structure; currently, such techniques are considered "old". Today, users refer to "New"Genetics in order to differentiate it from the "Old" Genetics. Old Genetics focused on rare hereditary diseases with a single gene mutation, affecting only a small portion of populations. New Genetics, however, deals with nearly all diseases–since most are genetic-related–that can affect large population groups. Furthermore, in recent years the term New Genetics has also been utilized to differentiate genetic studies from eugenics, since the former implies individuals' autonomy and freedom of choice while the latter suggests discrimination and prejudice.[10]

programs and/or integration of genomic components into education programs."[11]

Established in 1996, the National Coalition for Health Professional Education in Genetics (NCHPEG) is another professional group that notably promotes genomic education and competencies for all health professionals. More than 140 crossdisciplinary organizations, such as the ASPH and the American Academy of Nursing, are members of NCHPEG. The common core competencies in genetics, developed by NCHPEG, encompass 17 knowledge subcompetencies, 17 skills subcompetencies, and 10 attitudes subcompetencies.[12] Examples of knowledge subcompetencies include basic understanding of genetics terminology and "the influence of ethnicity, culture, related health

Table 1. The Definitions and Delimitations of Key Terms Frequently Used in Public Health Genomics in the United States (cont.)

Key Terms	Definitions and Delimitations
Public Health Genetics vs. Public Health Genomics	The distinction between *public health genetics* and *public health genomics* is similar to the one made between *genetics* and *genomics:* public health genomics covers a wider range of issues than *Public Health Genetics.* The definition of *Public Health Genomics* varies based on different organizations and countries. For example, according to the CDC, public health genomics is "the study and application of knowledge about the elements of the human genome and their functions, including interactions with the environment, in relation to health and disease in populations."[30] Yet, public health genomics is defined by the Public Health Genomics European Network (PHGEN) as "the responsible and effective integration of genome-based knowledge and technologies into public policy and into health services for the benefit of population health."[31] Despite such slight differences due to cultural and organizational variability, the central theme of public health genomics is an interdisciplinary field in which public health professionals should be able to integrate genomic and environmental information into public health research, practice, and policy.
Genetic Medicine vs. Genomic Medicine	The notion of *genomic medicine* is broader than *genetic medicine. Genomic Medicine* seeks to apply the knowledge and tools generated by the HGP into medical practice. Unlike genetic medicine, focusing on relatively uncommon, single-gene diseases, genomic medicine targets the majority of diseases which result from complex interactions of multiple genes and their environment(s). *Genomic Medicine* manifests itself as improved understanding of the biology of diseases and health, advanced gene therapies, patient-tailored pharmacotherapy, the utilization of increased genetic testing, and personalized medical care based on individuals' genomic profiles.[3]
Pharmacogenetics vs. Pharmacogenomics	*Pharmacogenetics* and *pharmacogenomics* are two similar disciplines which explore how individuals' genetic variations can affect their responses to drugs. The former, recognized in the 1950s, deals with single gene response to drugs; the latter, introduced in the 1990s, investigates multiple genes' responses to drugs with the assistance of new genomic technologies (e.g., microarrays). Based on individuals' genomic profiles, pharmacogenomics can be used to design personalized drugs to prevent and treat diseases. These can be expected to maximize the benefits of treatments and reduce medications' harmful side effects.[32]
Nutrigenetics vs. Nutrigenomics	*Nutrigenetics* and *nutrigenomics* are specific areas in nutrition science that are conceptually similar, but not identical, even though they are often used interchangeably. The discipline of *Nutrigenetics* investigates how individuals' genetic variations can affect their responses to specific nutrients. In contrast, nutrigenomics seeks to understand the effects of nutrients on individuals' genetic expression and regulation. The progress of nutrigenetics and nutrigenomics holds promise to prevent diseases by not only allowing the development of personalized nutrition plans according to individuals' genomic makeup, but also by designing specific food products for subpopulations that share similar DNA codes.[33]
Health Literacy vs. Genetic Literacy	*Health literacy* is defined as "the degree to which individuals have the capacity to obtain, process, and understand basic health information and services needed to make appropriate health decisions."[34] Health literacy is determined by an individual's education, existing health system, culture, and society. As a component of healthy literacy, *Genetic literacy* "focuses on the context or the environment within which individuals and communities share information about genetics, try to understand the meaning of that information in their lives, and deliberate and debate with others how the applications of genetics should be used and for what purposes."[35]

beliefs, and economics in the clients' ability to use genetic information and services."[12(p2)] Skills subcompetencies include the ability to "educate clients about availability of genetic testing and/or treatment for conditions seen frequently in practice" and to "provide appropriate information about the potential risks, benefits, and limitations of genetic testing."[12(p2)] Among the attitudes subcompetencies, "recognizing philosophical, theological, cultural, and ethical perspectives influencing use of genetic information and services" is one example."[12(p3)]

In similar fashion, the Institute of Medicine (IOM)—when articulating the training

Table 2. Reasons Why Health Educators Must Develop Genomic Competencies	
Argument 1	Because leading professional organizations have advocated the incorporation of genomics into health promotion practice.
Argument 2	Because health educators' professional competencies and responsibilities encourage and corroborate the incorporation of genomics into health promotion practice.
Argument 3	Because health educators' genomic competencies can significantly impact the lay public's utilization of, and satisfaction with, public health genetic/genomic services.
Argument 4	Because by developing their genomic competencies, health educators are better able to meet emerging health needs.
Argument 5	Because genomics and public health are generating unique opportunities for interdisciplinary collaboration, research funding, and employment.

needs for public health professionals regarding the interaction between genomics and health behavior—has set forth genomics as one of eight new content areas to be added to public health training curricula. These curricula should include basic and correct genomic knowledge as well as the ethical, legal, and social implications (ELSI) of genomics to ensure public health students "think genomically."[8(p70)]

Argument 2: Because health educators' professional competencies and responsibilities encourage and corroborate the incorporation of genomics into health promotion practice.

Defined and established by the Role Delineation Project (1979-1981), the responsibilities and competencies for health educators represent fundamental capacities and skills they need for planning, implementing, and evaluating disease prevention and health promotion interventions. The project delineated 7 responsibilities and 29 competencies for entry-level health educators; later, 10 responsibilities and 39 competencies were added for graduate-level professionals.[13] From 1998 to 2004, Gilmore and colleagues[13] spearheaded the National Health Education Competencies Update Project (CUP) to redefine health educators' responsibilities and competencies. This revision resulted in a more complex set of skills, comprising 7 areas of responsibilities, 35 competencies, and 163 subcompetencies, categorized as entry, advanced-1, and advanced-2 levels of practice.

Many of the professional responsibilities outlined in both the Role Delineation Project and the CUP are, implicitly, consistent with the incorporation of genomics into health education practice. In three CUP areas of responsibility, Area of Responsibility I, assess individual and community needs for health education; Area of Responsibility VI, serve as a health education resource person; and Area of Responsibility VII, communicate and advocate for health and health education—for instance it becomes clear that health educators have duties to assess communities' and individuals' needs, to respond to their needs, and to satisfy their requests regarding genomics information and education.

Furthermore, as Western societies continue to experience growth in demand for genomic services and persist in consuming biased or incomplete genomic information presented by media outlets,[14] health educators' responsibilities come even more sharply into focus. Increasing demands for individual genetic testing, population screenings, gene therapy, and genetic counseling—all of which involve significant decision-making components on the part of consumers—will spotlight health educators' responsibilities to facilitate voluntary choices and to provide accurate information and education. These responsibilities also include assessing communities' needs for genomic services, responding to their questions, and conveying realistic expectations about the potential harms, limitations, and benefits of various genetic services, including the reliability and validity of genetic testing, possible psychological stress after genetic profiling, and the availability of treatments.[4, 15]

Argument 3: Because health educators' genomic competencies can significantly impact the lay public's utilization of, and satisfaction with, public health genetic/genomic services.

The Interaction Model of Client Health Behavior (IMCHB)[16] provides a theoretical rationale for why health educators need to develop their genomic competencies. The model proposes that health professionals' affective support, health information, decisional control, and professional technique/competencies can influence their clients' health outcomes. In this model, clients' health outcomes encompass utilization of health care services, clinical health status indicators, adherence to recommended care regimen, and satisfaction with care.

Likewise, health educators' affective support, genomic information, decisional control, and genomic competencies can be theoretically expected to affect (1) the lay public' utilization of genomic services, (2) individuals' health status, (3) lay people's adherence to a healthy lifestyle after being informed of their genetic testing results and genomic profile, and (4) overall satisfaction with health promotion and disease prevention programs. In tandem with their ethical

responsibility to the public, it is important that health educators maintain the vision that they have a key role to play regarding the quality of health promotion services and that, in turn, such quality will increasingly be shaped by the kind of genetics-related education being provided.

Argument 4: Because by developing their genomic competencies, health educators are better able to meet emerging health needs.

The rapid pace of genomic discoveries is dramatically increasing the amount of information and tools available for use, yet the chasm between genomic knowledge and public health practice remains. This gap results, in part, from the slow progress in understanding the impact of genomic technologies and in translating information into effective interventions. Therefore, closing the gap between *knowing* and *doing* is a preeminent emerging need that justifies, in part, why health educators should develop their genomic competencies. In fact, many health educators have already begun to contribute toward minimizing this rift, for instance, by incorporating family history assessments into screening programs for high blood pressure and stroke prevention.[17]

A second emerging need is to address concerns stemming from the impact of direct-to-consumer (DTC) advertising campaigns for genetic testing. Although the American College of Medical Genetics stands against DTC genetic testing,[18] increased public interest in and demand for this type of testing can still lead to private genetic services marketed directly to consumers. These market pressures, coupled with limited regulation of DTC advertising for genetic testing, may generate unique problems for public health. These problems encompass clients' lack of adequate information and knowledge for pretest decision-making and interpreting of test results, as well as inappropriate test utilization (e.g., ordering a genetic test of dubious clinical validity and utility).[18,19]

BRCA1/BRCA2 testing for breast and ovarian cancer was the first genetic test marketed directly to the public. Women with mutated *BRCA1/BRCA2* genes have an increased likelihood of developing breast and ovarian cancer in their lifetimes. From September 2002 to February 2003, Myriad Genetic Laboratories, Inc. carried out a pilot DTC marketing campaign to advertise a *BRCA1/BRCA2* genetic test (BRAC*Analysis*®) to both women (age 25-54 years with breast and ovarian cancer family histories) and health care providers in Atlanta, Georgia, and Denver, Colorado. This DTC marketing strategy successfully increased both consumers' and health care providers' awareness of *BRCA1/BRCA2* testing. Yet, messages from DTC advertisements were misleading. For example, BRAC*Analysis*® was portrayed as a critical tool to detect consumers' cancer risk without informing them that only a small number of breast cancer cases are caused by mutated *BRCA 1/BRCA2* genes. Along with potentially misleading information, clients were motivated to order genetic screening tests directly from the manufacturer (to bypass potential difficulties with health insurance companies), without prior consultation with their health care providers.[19]

Despite such concerns, genetic testing for *BRCA1/BRCA2* will not be the last DTC marketing effort unless the Food and Drug Administration and the Federal Trade Commission can effectively regulate DTC advertising campaigns for such tests. At present, online DNA tests for breast/ovarian cancer, colon cancer, cystic fibrosis, and infertility are advertised and sold directly to consumers.[20] Health educators can, therefore, play an important role in preventing or mitigating the potentially harmful effects of self-prescribed genetic testing by raising the public's awareness and providing adequate education. Not only can health educators inform the public of the advantages, disadvantages, and limitations of online genetic tests, they can also engage in policy-making and client advocacy regarding regulation of genetics-related marketing efforts. Within this context, then, development of health educators' genomic competencies becomes both vital and urgent.

Alongside these emergent needs, the paucity of certified personnel to advise clients, coupled with genetic counselors' work overload, creates the need for health educators to play a role in the pool of available genetic services. In the United States, genetic counselors receive graduate degrees in the field of medical genetics and counseling from accredited universities. Genetic counselors' tasks include providing information–through a "non-directive" approach–regarding hereditary diseases and genetic tests, as well as connecting clients to community services and support systems. Presently, the National Society of Genetic Counselors estimates that approximately 2,100 genetic counselors serve more than 1.5 million clients each year in the United States, and most work in major urban medical centers.[21]

Parallel to the knowledge and practice gap, an important gulf between genetic/genomic needs and services exists, which health educators could help fill. Given their ability to work with various population groups, health educators could certainly provide genetic education and promote better understanding of genetic services, thus minimizing unwarranted anxiety and fear. While health educators could directly impact the provision of genetic/genomic services to populations with specific genomics-related needs, working within communities to promote awareness and to dispel anxieties regarding genetic services might contribute indirectly to the general public's understanding of the possibilities and limitations of genetic services, and to the improvement of the informed consent process for genetic testing. Community-based health education promoting the linkage of service providers, community agencies, and potential clients naturally falls under the scope of health educators' professional tasks.[15]

Argument 5: Because genomics and public health are generating unique opportunities for interdisciplinary collaboration, research funding, and employment.

Advancing PHG research and practice requires collaboration and engagement of professionals across various disciplines, including health education, special educa-

tion, medicine, pharmacology, nutrition, social work, physical therapy, occupational therapy, nursing, psychology, law, genetic counseling, and genetics. Collaborations among areas with different methodological traditions and professional training can foster better understanding of, and approaches to, all health issues in general, but particularly regarding the intersection of genomics and public health. Thus far, few interdisciplinary research reports have been published in the scientific literature, and the need for collecting baseline and educational outcomes data, for instance, is paramount.

Availability of funding for collaborative research and intervention might seem like a less-than-noble argument to persuade health educators to develop their genomics competencies. Yet it is encouraging to learn that the integration of genomics and health promotion is generating new funding opportunities, especially given the current diminishing resources for research and interventions regarding health behavior and education.

The first director of the NIH National Human Genome Research Institute, James Watson, suggested that a portion of the HGP budget should be used to study the ELSI of genomic research.[22] The NIH has, therefore, consistently made research funds available for research projects addressing the ELSI of genomic discoveries. The CDC and the Department of Health Resources and Services Administration (HRSA) are examples of other federal agencies encouraging genomic-related health promotion and disease prevention research. By way of illustration, in 2005, the CDC funded the University of Michigan's School of Medicine, the Evanston Northwestern Healthcare Research Institute, and Case Western Reserve University's School of Medicine to evaluate a family history tool. In 2006, the CDC funded 11 additional projects that proposed to adopt genomics into public health research and practice. Moreover, private donors such as the Robert Wood Johnson Foundation and the March of Dimes frequently offer grants to support studies related to genomics and health promotion.

In addition, a 1998 survey of employers such as schools of public health or preventive medicine, state/municipal health offices, insurance companies, HMOs, as well as biotechnology and pharmaceutical companies, revealed approximately 40% of respondents admitting they were "planning to hire individuals with competencies in public health genetics in the next 5 years."[23(p143)] This unique survey, conducted by the Genetics in Public Health Training Collaboration, revealed that employers valued specific genetic competencies such as "apply[ing] epidemiologic and statistical studies of disease with a genetic component" (considered important or very important by 78.4% of employers sampled), and "apply[ing] methods to address ethical, legal, social, and financial implications of genetics in public health" (70.3% considered this important/very important). Respondents who rated these competencies as important or very important planned "on hiring individuals with that competency skill in the next 5 years."[23 (p146)]

DISCUSSION AND IMPLICATIONS

In this article we proposed five arguments supporting the need for health educators to develop their genomic competencies and integrate PHG into health promotion/education. These arguments touched on various dimensions of health educators' professional goals and ranged from professional responsibilities and competencies to the availability of funding for genomic-related research or interventions and opportunities for future employment. Alongside these arguments, we presented a brief listing of key PHG terms–with their most widespread definitions–in order to facilitate understanding of the issues and establish a common set of meanings for readers.

The impetus for outlining this structured rationale in the *American Journal of Health Education* originated when we began to conduct research in the area of PHG. The more we learned about the PHG "world," the more the absence of appreciable health education initiatives and of health education professionals' involvement with the topic, became apparent. Professional genetic counselors–given their small numbers–are struggling to meet their clients' needs, and public health organizations (as well as civic groups, worldwide[10]) are clamoring for easily accessible education and information regarding PHG. If these scenarios are valid, *where are the health educators*?

Granted, efforts to incorporate genomics into health promotion research and practice are in place at many levels, but the profession is still very far from any sort of "tipping point." Some efforts worthy of notice include revisions made to Green and Kreuter's PRECEDE-PROCEED planning model.[24] In the most recent edition of their classic book *Health Program Planning: An Educational and Ecological Approach* (2005), the authors included "genetics" as a core element in the model's epidemiological assessment phase. "Genetics" now stands alongside "Behavior" and "Environment" as a factor that bears upon individuals' and populations' health and, as such, must be considered when planning, implementing, and evaluating effective interventions. Inclusion of a genetics element in this model undoubtedly "forces" health promoters to consider this dimension in their planning of behavior-change programs, by promoting consideration of genetic aspects of the particular health behavior being targeted for change.

Other instances where professional strides have begun include offerings of courses and/or professional development opportunities at various public health training programs nationwide, including the schools of public health at the University of Michigan, the University of Washington, and the University of North Carolina at Chapel Hill. In 2003, for example, the University of Washington implemented the first doctoral program in public health genetics in the United States and the world. Moreover, national and international professional conferences have gradually increased their emphasis on PHG (e.g., the 2006 annual meeting of the American Public Health Association; the 4th DNA Sampling Conference on Public Health Genomics, held in Canada in 2006; and the 2006 CDC

National Health Promotion Conference, with the theme of genetics/genomics). Very few presenters at these meetings are health educators, however, and most topics are not presented from a health education perspective. Lastly, professional textbooks in various fields have also begun to reflect the emerging emphasis on PHG. Texts are being published on human genome epidemiology, clinical genetics in nursing practice, genomic medicine, nutritional genomics, and pharmacogenetics. While proposals for PHG textbooks may be circulating among publishing houses at this moment, health educators do not yet have access to quality publications focusing on the role of health education in PHG.

The arguments presented in this article were intended to provide health educators with a multidimensional view of the need for incorporating genetics/genomics into health promotion practice and research. It is important to recognize, however, that most of these dimensions are rooted in an ethical mandate. As outlined in the Code of Ethics for the Health Education Profession, health educators share important values and responsibilities regarding their practice, including responsibility to the public and employers. Yet, ultimately, health educators have an ethical responsibility to the profession. Public health or health education professionals who developed genomic competencies can help meet the standards established by *Healthy People 2010* [25] for high quality public health programming. Failure to incorporate genomics into public health education, however, carrier with it the risk of being perceived as condoning unethical conduct, and will lead to a stagnant field and an outdated workforce.

In presenting these five arguments, we take an important step toward increasing health educators' awareness of PHG. An equally significant and rather large task remains, however: to devise the mechanisms that will facilitate health educators' incorporation of PHG into their health promotion research and practice. As starting points, the IOM has suggested that efforts be made to (1) assess the impact of genomic information on the lay public's short- and long-term behavioral changes, and (2) explore the ELSI of genomic information and technologies.[26] Similarly, Wang, Bowen, and Kardia[15] outlined three areas for immediate research and practice opportunities in health promotion: assessment of the public's understanding of genetics; evaluation of interventions for health behavior change (with emphasis on evaluating the impact of genomic information on individuals' lifestyle changes and clarifying the influences of family histories on individuals' health behaviors); and "public health assurance and advocacy,"[15(p692)] through reduction of the harmful effects of DTC advertising for genetic testing, as well as prevention of potential health disparities resulting from genetic discrimination or unequal public access to genetic/genomic services. Engaging in such tasks would sharpen health educators' perceptions of the need for genomic competencies and would provide the appropriate context for their development.

With the completion of the HGP, "the genomic era is now a reality,"[1(p835)] and health educators are called upon to adapt and develop new competencies. Undoubtedly, much has yet to be defined (e.g., what specific genetic/genomic knowledge will health educators need to have?) and established (e.g., development of master's-level training programs for health educators interested in PHG). Nevertheless, as we undertake this "road less traveled," our profession will improve, and we will have made an ethical choice.

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